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Harvesting Costs for Different Intensities of Thinning in Even-Aged Tolerant Hardwood Stands

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Technical Note

Harvesting and Operations

Introduction

Commercial thinning prescriptions in hardwood stands are fairly new to forestry operations in New Brunswick. There are a few studies available on harvester productivity and factors affecting the machine's operational effectiveness in these hardwood stands (Girard 2009, Vincent Roy 2010). It is generally assumed that there is higher harvesting cost for thinning operation because (1) there is lower harvested volume per hectare, (2) trees are less visible within the stand, (3) harvester's mobility is obstructed by residual trees, and (4) there is a need to protect residual trees. In this context, in order to demonstrate average harvesting cost associated to different intensity thinning, we investigated the effects of different thinning intensities on a single grip harvester productivity in southern New Brunswick. The residual stand densities were maintained at three different levels when referring to a stand density management diagram; 1) Q-line: stocking level suggested to ensure natural shedding of live branches, 2) B-line: the lower limit of stocking needed for full occupancy of the site, and 3) C-line: stocking level which is expected to reach B level within 10 years.

Highlights

- ***On average, 10 to 15\$/m^3 is the cost of thinning young even-aged tolerant hardwood stands in New Brunswick (harvester only in CTL operations).***
- ***There is a higher harvesting cost per unit volume for intermediate thinning intensity (B-line) in small diameter stands.***

Methodology

The study site was chosen with the consultation of the foresters at the AV Group NB Inc., of Nackawic. Three blocks (NHRI001, NHRI002 and NHRI004), located near Canterbury, New Brunswick (Figure 1), were selected for the study. In all blocks, trees originated from a clear cut (1980-81) and then pre-commercially thinned in the late 1990's. The blocks were then subdivided into four plots to apply thinning treatments with different residual stand conditions (Control, Quality line, B-line and C-line), except for NHRI004. This last block was subdivided into three plots (Control, B-line and C-line) as it had a low initial basal area, which did not meet Q-line criteria. Extraction trails were set at every 23 m (center to center) with an average width of 4.5m.

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The study compared the productivity of mechanized felling at different intensities of commercial thinning using productivity information of the same equipment and operator. A Landrich machine with a Ponsse H8 harvesting head equipped with a top saw was used for evaluating harvesting productivity. It has a tracked machine powered by a Mercedes engine (same as in Ponsse equipment). Harvester productivity was evaluated by using the data captured by the Ponsse OPTI system on-board computer located in the harvester. The information that are provided by the system are product volume (m^3) from the production files (.prd) and productive machine hours (pmh) for all the blocks and plots. Operator was instructed with the guidelines for three different intensity commercial thinning treatments (Table 1). Stem level productive machine hours information was used to calculate harvesting cost (Equation 1), where 150$/pmh was considered for the calculation, and where:

HC = Harvesting cost per m^3

PMH = Productive machine hour

R = Rate (150$/hour)

V = Stem volume (m^3)

$$HC = \frac{PMH \times R}{V} \qquad (1)$$

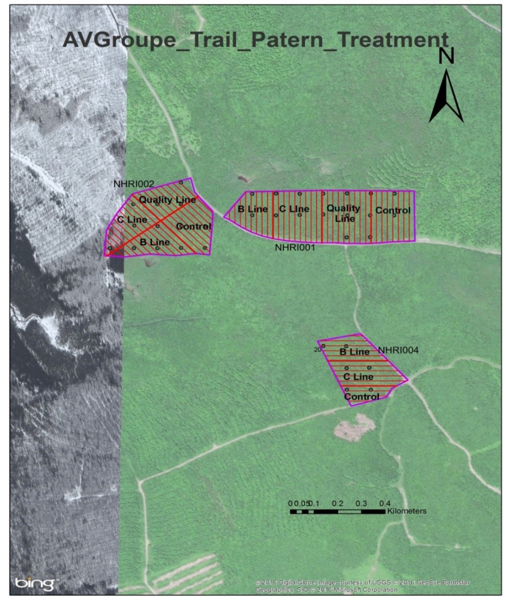

Figure 1: Location of the study sites with the alignment of |extraction trails.

Table 1. Operator's guidelines for different commercial thinning treatment

Activities	Treatment 1 Quality Line	Treatment 2 B Line	Treatment 3 C Line	Control
Trail Network	Trail width: 4.5 m, Trail spacing: 23m (center to center)	Trail width: 4.5 m, Trail spacing: 23m (center to center)	Trail width: 4.5 m, Trail spacing: 23m (center to center)	NA
Thinning type	Free thinning	Free thinning	Free thinning	NA
BA* (m^2/ha)	18	14	11	Untouched
Initial BA (m^2/ha)	23	19	18	NA
Pecking Order**	1) UGS 2) AGS>38cm 3) Softwoods & Beech	1) UGS 2) AGS>38cm 3) Softwoods & Beech	1) UGS 2) AGS>38cm 3) Softwoods & Beech	NA

*Inside thinning zone (excludes trail area)

**AGS: Acceptable growing stock, good form and low risk of losing vigor and UGS (Unacceptable Growing Stock) are the terms used to classify trees according to species, form and risk (Detail: Pelletier et al. 2016).

Table 2. Results of the harvester productivity using the Ponsse Opti System

Block-plot	Area (ha)	Volume harvested (m^3)	Stems (#)	m^3/Stem	PMH	m^3/PMH
1-Q	5.8	192.11	1649	0.117	19.55	9.827
2-Q	3.3	69.34	461	0.150	5.53	12.539
1-B	5.0	128.31	907	0.141	10.22	12.555
4-B	2.9	64.95	691	0.094	7.41	8.765
1-C	5.6	251.08	1953	0.129	23.23	10.808
4-C	3.7	120.67	848	0.142	8.46	14.264
2-C	3.6	75.82	516	0.147	6.63	11.436

Results

Table 2 presents the results of the harvester productivity using the Ponsse Opti System. We observed minor differences in harvester productivity and harvesting cost among the three different levels of commercial thinning (Q-line, B-line and C-line) being highest at the C-line (Figure 2A and 2B). However, it was not possible to show statistically significant difference among them as we did have adequate number of sample plots. Harvester productivity (m^3/pmh) increased exponentially with increasing tree size (Figure 3). Harvesting cost ($/m3) was decreased with increasing stem size. Average harvesting cost ($\$/m^3$) was significantly higher in B-line treatment than in Q-line and C-line treatments for smaller stem sizes (< 0.1 m^3). When average stem size was greater than 0.1m^3, average harvesting cost ($\$/m^3$) was less than 10$ and did not vary significantly among treatments (Figure 4).

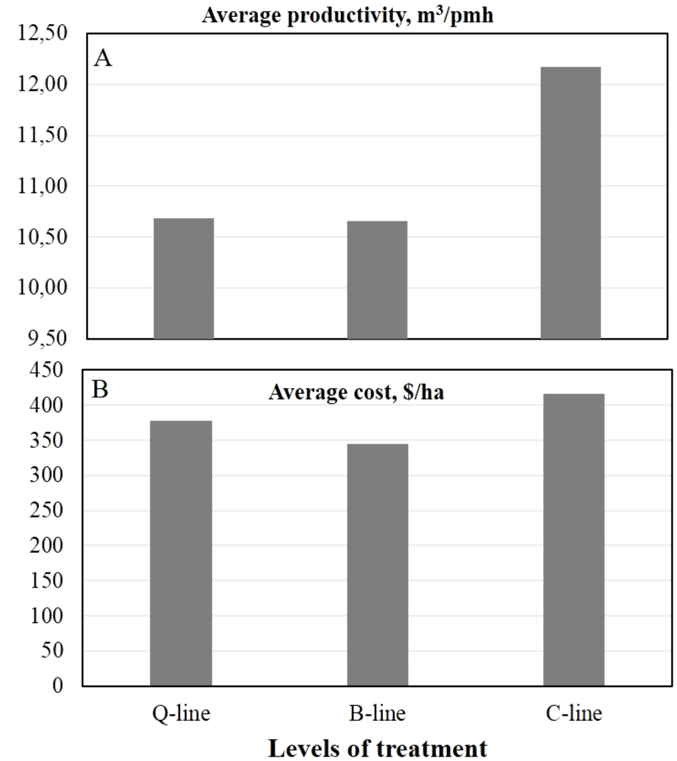

Figure 2: Average productivity (A) and harvesting cost (B) at different levels of thinning

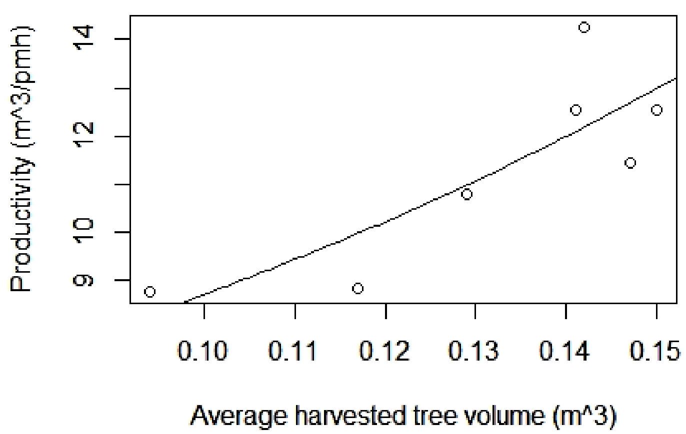

Figure 3 (above): Relationship between average productivity and trees size (defined as average harvested tree volume)

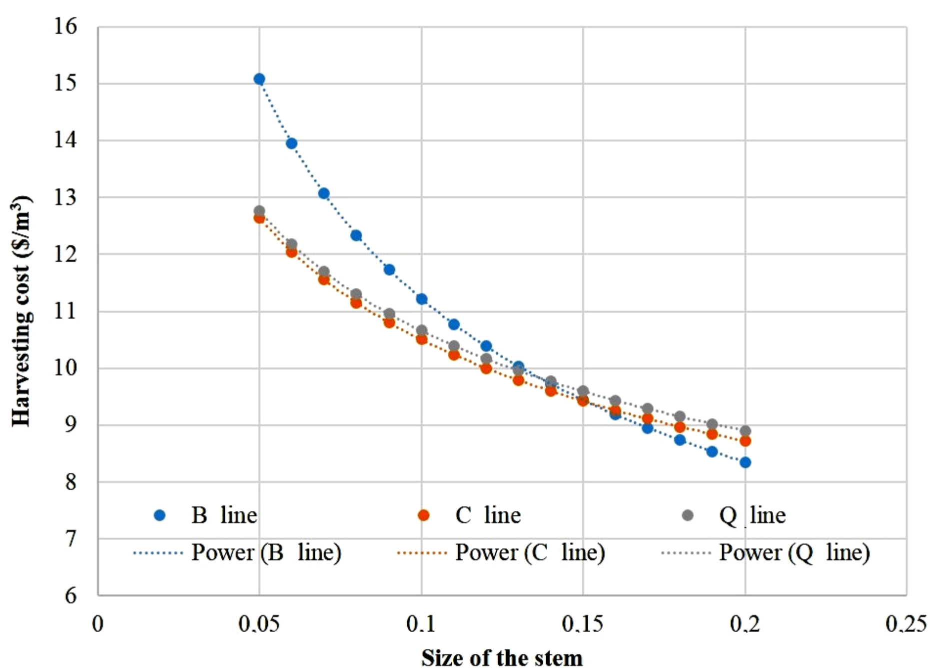

Figure 4 (right): Harvesting cost ($\$/m^3$) with increasing stem size (m^3) at different thinning treatment.

Discussion and conclusion

Average harvesting cost ($/m^3) of different intensity thinning in young, even-aged tolerant hardwood stands in central New Brunswick ranges between 9 to 15 $/m^3 when 20 to 50 m^3/ha of merchantable volume is harvested and average tree diameter at breast height is between 14-18 cm. Similar to previous studies, our findings demonstrate that average size of the harvested trees is an important factor that is related to harvester productivity (Hiesl and Benjamin 2013; Spinelli et al. 2010). Hiesl (2015) concluded that stand density, basal area, hardwood content, and removal intensity were not significant in explaining variation in harvester productivity. However, this study indicates that thinning to B-line in smaller diameter stand increases harvesting cost per unit volume than thinning to Q-line or C-line. The reasoning for this result is that the harvester's operator has practically no thinning selection decisions to make for Q-line thinning because of the low initial basal area and low volume to harvest. All the harvested trees were likely to be located in or near the extraction trail with the less chances of cutting trees in the leave strip. On the other hand, the C-Line having more volume per hectare to harvest showed a better harvester productivity (thus, lower cost $/m^3) than the B-Line scenario which had less volume (per hectare) available to harvest (Table 2) and, thus, operator might have spent more time on finding trees to cut in the leave strip.

Only the limited data was used for this study due to logistics constraints. Therefore, caution must be provided while generalizing the findings of this study. Moreover, the choice of machine was not the optimal for the task, nevertheless it did an acceptable job. The Landrich Harvester with a H8 Ponsse head is relatively big in size for commercial thinning which may damage residual trees when trying to access trees to harvest. The good side, however, was the speed at which the feed rollers were running combined with a good sharpening of the knives by the contractor. That combination of delimbing and processing was very effective and productive. Also, the trail spacing at 23 metres might not be optimal for the reach capacity of this harvester. As a result, non-treated strip was created in the middle of the leave strip.

References

Girard, P. 2009. A comparison of the productivity of mechanized clearcutting and selection cuts of hardwood and mixed forests. Advantage, volume 11 (8):1-8.

Hiesl, P. 2015. Forest harvesting productivity and cost in Maine: New Tools and Processes. Ph. D. Thesis. University of Maine.

Hiesl, P. and Benjamin, J.G. 2013. Applicability of international harvesting equipment productivity studies in Maine, USA: A literature review. Forests 4(4), pp. 898–921.

Pelletier, G., D. Landry and M. Girouard. 2016. A Tree Classification System for New Brunswick. Northern Hardwoods Research Institute. Edmundston, New Brunswick.

Raffaele S., Hartsough, B. R. and Magagnotti, N. 2010. Productivity standards for harvesters and processors in Italy. Forest Products Journal: May 2010, Vol. 60, No. 3, pp. 226-235.

Vincent Roy, F. E. 2010. Commercial thinning in high value hardwood stands. FP Innovations, Pointe-Claire, QC, Canada.

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